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ECONOMIC AND DISTRIBUTIONAL IMPACT OF COVID-19: EVIDENCE FROM MACRO-MICRO MODELLING OF THE SOUTH AFRICAN ECONOMY

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Abstract
A computable general equilibrium model linked to a microsimulation model is applied to assess the potential short-term effects on the South African economy of the ongoing COVID-19 pandemic. With a particular focus on distributional outcomes, two simulations are run, a mild and a severe scenario. The findings show significant evidence of decline in economic growth and employment, with the decline harsher for the severe scenario. The microeconomic results show that the pandemic moves the income distribution curve such that more households fall under the poverty line while at the same time, inequality declines. The latter result is driven by the disproportionate decline in incomes of richer households while the poorest of the poor are cushioned by government social grants that are kept intact during the pandemic. The COVID-19 pandemic is still unfolding and its economic modelling as well as the data used to operationalise the model will need to be updated and improved upon as more information about the disease and the economy becomes available.
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1. INTRODUCTION

The ongoing novel coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first discovered in China in November 2019. Since the outbreak, COVID-19 subsequently spread rapidly to almost all countries in the world. On 30 January 2020, the World Health Organisation declared COVID-19 a public health emergency of international concern and thereafter pronounced it a global pandemic on 11 March 2020. As a novel virus outbreak, COVID-19 has no known vaccine to date.

South Africa recorded its first case on the first of March 2020 and by 12 March 2020, the number of confirmed cases had risen to 16. A national state of disaster was declared on 16 March 2020, with a partial travel ban, closing of schools and prohibiting gatherings of more than 100 people, among other measures. It soon became clear that the virus was now spreading locally predominantly through community infection and subsequently a state of lockdown for 21 days was imposed on the economy. On that date, a total of 927 active cases had been confirmed in all the nine provinces. The state of lockdown has since been extended for more than 100 days, but with the gradual opening of the economy taking place since June 2020.

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The first lockdown entailed several measures, including total closures of economic activities that were deemed non-essential; closures of schools, colleges and universities, the prohibition of gatherings and closure of all borders, among other measures. Most of the world, among them South Africa's trading partners, also implemented some form of lockdown which included the closure of borders, and no non-essential trade and travel.

The pandemic hit the South African economy at a time that the economy was already under substantial strain. Economic growth had fallen to 1.5% in 2019 compared to 3% in 2010. Indeed, in the fourth quarter of 2019, the economy had entered a technical recession. Unemployment had soared to 27.3% the first quarter of 2019 and by the third quarter it had reached 29.1% (Statistics South Africa, 2019a). At the same time, while poverty had registered some improvement since 2015, it remained very high at 49.2% in 2019, compared to 55.5% in 2015. Inequality, on the contrary, had not shown similar tendencies to reduce as had poverty (Sulla and Zikhali, 2018).

Given this already bleak picture and the undoubtedly devastating effects from the pandemic, it is imperative to try and understand the extent to which this pandemic will further plunge the economy into a decline and trace the transmission channels of the impacts. Translating the impact of the disease, as well as the subsequent regulations by the government in response to the pandemic into economic impacts can be a worthwhile exercise because it gives a glimpse into the potential economy-wide impact of the pandemic. Such information can be useful to gauge the extent of the damage, and therefore, the possible extent of the needed policy response.

Modelling the effects of the COVID-19 pandemic on the economy is fraught with huge challenges. Not only is the pandemic novel with the consequence that not much prior modelling literature of the pandemic to go on exists, but also the pandemic is still ongoing. Thus, there is no certainty as to how it will eventually unfold. To further complicate an economic modelling exercise such as this is the fact that there are several possible channels through which the health crisis potentially feeds into the rest of the economy. Scenario analysis using a computable general equilibrium (CGE) model can be highly effective for such an exercise, since the COVID-19 pandemic constitutes a large national-scale shock that is disrupting sectors and people both directly and indirectly with spillover effects throughout the economy (via supply chains, reduced incomes and consumer demand).

This paper, therefore, uses a CGE model to assess the impact of the COVID-19 pandemic and immediate containment policy responses on the South African economy, with a particular focus on the immediate impact on production, poverty and inequality. It is important to mention that the assessment is limited to the impact of the responses that government put in place to contain the virus, the most profound of which was locking down the economy, as well as reduced global economic activities. The assessment is, therefore, not on the impact of the epidemiology itself, but on the effects that reactions to the pandemic had on the economy and households. Furthermore, we do not assess the effects of additional expenditure (such as on health and personal protective gear), or expenditure reprioritisations following the pandemic outbreak in South Africa. The usefulness and appropriateness of such modelling are demonstrated in several CGE papers and reports that have modelled past pandemics, such as on the Acquired Immunodeficiency Syndrome (AIDS) (Kambou *et al.*, 1992; Arndt and Lewis, 2001; Dixon *et al.*, 2002), on Ebola (Evans *et al.*, 2014; Fofana *et al.*, 2015) and on various types of influenza (Lee & McKibbin, 2004; Bloom *et al.*, 2005; McKibbin and Sidorenko, 2006; Brahmbhatt

and Datta, 2008). While such papers, and indeed modelling from other past pandemics offer some valuable lessons, it remains the case that the majority of past pandemics are quite different in their transmission channels to economic impacts. There has not been any shock such as this in a period with such global connectivity as exists today. The international reactions following the pandemic to virtually cease most economic activity and international transactions are unprecedented. Thus, while past literature might assist partially, it cannot be solely relied on to fully account for unique country features. Therefore, modelling the impact of COVID-19 becomes somewhat more challenging than usual because not only there little information about the disease, but also there are no close economic modelling comparisons from history.

Some useful literature has recently started emerging on how to model COVID-19 in a CGE model (for instance, Maliszewska *et al.*, 2020; Laborde *et al.*, 2020). These papers track the impact of the pandemic into the economy via some or all of the following channels: the reduction in employment due to economy shutdown regulation, the decline in demand especially of goods deemed non-essential, the reduction in travel and international trade and the increase in transport costs. Lessons from these recent papers, that are relevant to South Africa, will be utilised but some level of judgement will be inevitable in translating responses of the health pandemic into the economy for scenario building. For instance, an important issue that will become extremely important as the pandemic continues to unfold with an important bearing on modelling choices relates to proper representation of both demand and supply effects and whether indeed to represent both or to select just one of them when designing the shocks. In this paper, the choice has been made to model the lockdown from the supply side constraint. This and other similar related judgement issues are discussed in greater detail later in the paper. The rest of the paper is arranged as follows. Section 2 discusses the model used, followed in Section 3 by the scenario building assumptions. Section 4 discusses the results, while Section 5 concludes the paper.

2. METHODOLOGY

2.1. Model

A CGE model is used to evaluate the impacts of the COVID-19-induced lockdown on the economy. The CGE model is then linked to a micro model in order to assess the redistributive impacts on poverty. CGE models can represent the whole economy, which enables capturing the different impacts of the COVID-19 (international and domestic impacts) on the different institutions. The models can capture direct as well as indirect impacts of such a large national-scale shock. The model used builds from the Partnership and Economic Policy (PEP) 1-1 model developed by Decaluwé *et al.* (2013) and modifies several assumptions in order to capture important South African realities.

The model uses the Social Accounting Matrix (SAM) for South Africa built for 2015 by van Seventer *et al.* (2019) and updates it to 2020. A SAM is a snapshot of the economy that represents the different flows existing among the activities, commodities and institutions, as well as the flows among institutions (direct taxes paid, dividends received, etc.) for a given year. Each cell of the SAM is identified with a variable in the model. In line with the SAM for South Africa, the model has 51 activities and 79 commodities. Constant returns to scale presented in a four-level production process is assumed for the production function technology. At the first level, for each activity, production is a

Leontief function of value added and intermediate consumption. At the second level, it is assumed that composite labour can be substituted with capital following a Constant Elasticity of Substitution (CES) function. At the third level, composite labour is a CES function between skilled and lower skilled workers. Highly skilled and skilled workers are those with tertiary education and those who have completed secondary education (grade 12), respectively. Semi-skilled and unskilled labour is comprised of workers with middle school education (grades 8-11) and workers with primary education (up to grade 7). At the fourth level, a CES function between workers with tertiary education and workers with completed secondary school education is assumed. Each activity uses intermediate goods and services, capital and the different types of labour, although, in different proportions. For instance, a sector such as basic iron and steel relies particularly on intermediate consumption to produce (88.8% of its production) while another sector, such as public administration, intensively uses labour, and among labour, mainly skilled workers (41.2% of its wage bill). Consequently, if the public sector was negatively impacted by COVID-19, one would expect that skilled workers would be particularly affected.

The model distinguishes four different institutions, namely, households, firms, government and the rest of the world. Following the SAM, households in the model are disaggregated per decile of income. They receive their income from labour, capital and transfers. As we are interested in distributional impacts of COVID-19, we present in Tables 1 and 2, the different sources of income and spending for the different households. These two tables provide information on the structure of income and spending for the different households, which is quite different given the deciles, and will help our understanding of the results after the shocks. Indeed, households at the bottom of the distribution mainly receive transfers from the government (69% of their income) and unskilled labour income, while richest households receive income mainly from highly skilled labour income and dividends from firms (Table 1). Thus, if the industries most affected by the pandemic employ a majority of unskilled workers, then, it is the poorest households that will suffer the most.

Households use their income for paying taxes, transfers to other institutions, consumption and saving. On the consumption side, household behaviour is modelled as a Linear

Table 1. Households' sources of income (in percent of their total income)

	flab-p	**flab-m**	**flab-s**	**flab-t**	**fcap**	**ent**	**gov**	**row**
hhd-0	15.44	9.38	1.68	0.10	2.81	1.49	69.04	0.06
hhd-1	14.29	9.50	4.76	0.85	5.32	2.35	62.83	0.09
hhd-2	9.59	11.24	8.27	1.65	7.45	4.36	57.28	0.16
hhd-3	9.02	11.93	12.22	1.61	9.82	5.79	49.39	0.22
hhd-4	7.53	13.58	14.77	3.89	13.00	6.78	40.19	0.25
hhd-5	6.86	13.99	19.75	8.26	14.92	7.60	28.34	0.29
hhd-6	4.30	9.72	26.92	13.15	18.81	10.66	16.03	0.40
hhd-7	2.48	9.41	22.53	24.20	18.50	13.52	8.85	0.51
hhd-8	0.99	4.37	18.18	40.10	15.90	16.78	3.04	0.63
hhd-9	0.62	1.14	9.11	49.01	15.88	22.77	0.60	0.86

Note: flab-p refers to labour income from primary school education, flab-m refers to labour income from middle school education, flab-s refers to labour income from completed secondary school education, flab-t refers to labour income from tertiary school education; fcap refers to capital income; ent refers to enterprises; gov refers to the government; row refers to the rest of the world. hhd-0 refers to households in the first decile, hhd-1 refers to households in the second decile etc.

Source: Computations based on the SAM by van Seventer *et al.* (2019).

Table 2. Sources of spending (in of their total income)

	hhd-0	hhd-1	hhd-2	hhd-3	hhd-4	hhd-5	hhd-6	hhd-7	hhd-8	hhd-9
Consumption spending	99.79	99.26	98.43	97.39	94.75	90.56	87.06	78.37	68.00	55.32
Transfers to firms	0.09	0.25	0.51	0.96	2.16	3.15	4.54	8.94	10.14	14.54
Transfers to government	0.03	0.17	0.38	0.59	1.12	2.34	3.14	4.75	8.27	10.88
Direct taxes	0.05	0.27	0.61	0.93	1.78	3.72	4.98	7.53	13.11	17.26
Transfers to abroad	0.00	0.01	0.01	0.02	0.05	0.08	0.11	0.22	0.25	0.36
Savings	0.03	0.04	0.06	0.10	0.12	0.15	0.16	0.19	0.24	1.64

Note: hhd-0 refers to households in the first decile, hhd-1 refers to households in the second decile etc.

Source: Computations based on the SAM by van Seventer *et al.* (2019).

Expenditure System and subject to the household's budget constraint. Households in the first two deciles spend almost all of their income on consumer spending (more than 99%) while this proportion is only 55% for households in the last decile (Table 2). Having this information in mind, we can expect that, with a decrease in households' income, sectors producing the commodities consumed by households will be indirectly affected.

Firms mainly derive their income from capital plus transfers from other institutions. They pay corporate tax, make transfers (dividends) to other institutions and save the remainder. Government's income is derived from direct taxes paid by households and firms, indirect taxes on domestic sales, import tariffs, transfers from other institutions and a share of capital income. From the SAM, we see that direct taxes represent more than a third of government's income. Among direct taxes, taxes paid by the richest households represent 43% of the total direct taxes. Therefore, if the impacts of COVID-19 were to reduce the income of the better-off households, there would be negative consequences for government income. In our model, government savings is computed as government income less its consumption and transfers paid to other institutions (*e.g.* social grants, pensions etc.).

To link South Africa and the rest of the world, the traditional CGE modelling approach, whereby trade is modelled based on the assumption of imperfect substitutability of commodities given their origin (the Armington assumption), is used. South African producers can either sell on the local market or export their production. To increase their world market shares, they need to be more competitive on the international markets. Technically, this hypothesis is translated in our model by the use of a finite elasticity for the export demand.

Standard CGE models assume full employment. This standard hypothesis does not hold in the South African context, where unemployment is a major issue. The very high unemployment rate in South Africa is modelled following Blanchflower and Oswald (1995) and assumes there is a negative slope between unemployment rates and wage rates. Kingdon and Knight (2006) show that the elasticity of wages to local unemployment rates in South Africa is similar to that found in other countries analysed by Blanchflower and Oswald (1995). Specifically, they found that a 10% increase in the unemployment rate leads to a 1% decrease in wages. Labour is mobile across sectors, whereas capital is sector specific.

In terms of other closure rules, the nominal exchange rate is the numeraire. Government's spending is exogenous. The rest of the world's savings is exogenously given. Finally, South Africa takes world prices as given, which flows from the small country assumption.

2.2. Data

As mentioned earlier, the database used for the CGE model is a SAM. A SAM is a consistent framework representing all the flows recorded within the economy for a given year. Additional data such as income elasticity from Burger *et al.* (2017) and trade elasticities from Ntombela *et al.* (2018) are used to operationalise the model.

On its own, the CGE model does not allow for assessing explicitly the poverty impacts of the COVID-19 pandemic. To enable such explicit poverty and distributional analysis, the CGE model is linked to a micro module using a top-down technique, meaning that the macro results on households' income and prices feed the micro component of the model. Poverty impacts are evaluated using the Foster *et al.* (1984) indexes. The National Income Dynamics Study (NIDS) Wave 5 (Southern Africa Labour and Development Research Unit, 2018) data are used for poverty analysis.

3. SCENARIOS DESIGN

The COVID-19 pandemic is affecting the South African economy in many ways through both international and domestic channels of transmission that are used to inform the design of the scenarios. Under the international channels, the country faces a decrease in demand for its exports given the economic situation in trading partner countries. Indeed, China, the United States of America and European countries, which are major trade partners for South Africa, face a lockdown or a severe slowdown of their economies, and therefore, reduce their demand for imports from the country. China, Germany and the United States of America are the three main markets for South African exports accounting for approximately 25% of its total exports (World Bank, 2018). While the epidemic appears at present to be contained in China, it is still present in Germany and very active in the United States of America at the time of writing this paper. As a result, COVID-19 is having an impact on these economies whose full extent is not yet known.

Moreover, there is a drop in oil price and mineral prices on the international markets. South Africa is a net oil importer but exports many minerals, with coal, gold and manganese representing 30% of total exports. Finally, on the international transmission channel, South African households receive some remittances from the rest of the world (dividends, relatives or friends residing and working overseas etc.). From Table 1, it can be seen that the share of remittances in household income is relatively small and it is mainly the better-off households that receive such transfers. It is assumed that during the COVID-19 scourge, this source of income dries up due to the economic situation overseas.

Focusing now on the domestic channels, the country is affected in several ways. First, because of the lockdown, the majority of the population is staying at home and teleworking where possible. However, teleworking is not an option that is feasible for many workers, especially the lower skilled workers (Kerr and Thornton, 2020). Being at home, workers are not using the capital in the factories, which becomes unutilised. The decrease in the productivity of labour and capital has an impact on the production of all sectors, but some are more affected than others are. Then, as mentioned, the government declared some sectors non-essential, and these had to close or reduce operations during lockdown. Following Arndt *et al.* (2020) and Bhorat *et al.* (2020) who provide the most up to date evidence, the sectors of the economy are classified according to their degree of exposure

to the shock, (see Appendix Table A1). For example, the health and social work sector is considered as mildly affected, while the tourism and transport sectors are considered as severely affected. The severely affected sectors are negatively affected given the national and international restrictions, including that flights are limited, and tourists are not travelling to and within the country. Bhorat *et al*. (2020) provide some insights based on two surveys, one at an individual level from Genesis Analytics and the other from Statistics South Africa at a firm level. Though none of these surveys can be representative for the country as a whole, each provides useful information and confirms hypothesis regarding the potential impact of COVID-19 during lockdown. For instance, they find that there is no sector of the economy in which all firms are working at full capacity during the time of the survey. For some activities, such as agriculture, forestry and fishing or utilities, a bit more than 20% of the firms in these sectors report working at full capacity, while for sectors such as trade, less than 5% of the firms in this sector report working at full capacity. None of the firms in the construction sector report working at full capacity, while 70% of the firms report being temporarily closed. Hence, based on these findings, the construction sector is considered as "very severely affected" while the agricultural sectors would be considered as "mildly affected." Table A1 in the appendix presents the assumptions we made for the different sectors. Second, an increase in the transport costs for commodities given the situation of the pandemic is also considered. For instance, haulage trucks are no longer operating at optimal capacity because of reduced economic activities, *e.g*., it now takes longer to fill up a truck trailer compared to when activities are at full capacity.

Based on the identified channels of the COVID-19, two scenarios are designed, a mild and severe one (see *e.g*. Arndt *et al*., 2020; Calderon *et al*., 2020). Table 3 summarises the simulations. For both scenarios, as there is no existing data on the magnitude of the shocks, we design our scenarios using hypothesis from other studies (Arndt *et al*., 2020; Calderon *et al*., 2020; Laborde *et al*., 2020) and adjusting them to the South African context. In other words, we are conscious that our scenario designs are based on "guesstimates." To design the severe scenario, we assume two main hypotheses. The first one is based on the economic situation internationally. The virus is still active in many parts of the world, and consequently, it takes more time than expected for the major trading economies to recover. As a consequence, their demand for imports from South Africa will be more subdued. Moreover, given the persistence of the pandemic in western countries and the related economic slowdown in these countries, the demand for minerals

Table 3. Assumptions of the simulated scenarios

	Mild scenario	**Severe scenario**
International channels		
Decrease in exports	10% for all commodities	15% for all commodities
Decrease in world prices for oil and minerals	20% decrease for oil price 8% decrease for minerals	20% decrease for oil price 10% decrease for minerals
Decrease in remittances	10%	10%
Domestic channels		
Decrease in productivity for the sectors	2% for mildly affected 5% for moderate 10% for largely affected 15% for severely affected	5% for mildly affected 8% for moderate 13% for largely affected 17% for severely affected
Increase in transportation cost	2%	2%

Source: Own compilation based on Arndt *et al*. (2020) and Bhorat *et al*. (2020), as well as informed by government lockdown regulations.

continues to be low, and therefore, we assume a sharper decrease in the mineral world price. The second hypothesis to build our severe scenario is based on the assumption that domestic sectors are affected for a longer period by reduced productivity. In other words, the remote work would continue for longer, and/or the social distancing measures would limit the speed of return to normal path of production. We have decided to keep the same magnitudes for the remittances and transportation costs in the two scenarios. The remittances represent a very small part of households' income (see Table 1), so we do not believe that the results would have changed substantially by changing these. Regarding the transportation costs, we believe that the transport sector adjusts to the new situation, and therefore, there is no greater increase than the 2% assumed in the mild scenario.

Technically, to implement the identified channels in our model, we decrease the initial value of exports in the export demand function by the corresponding amount (first shock identified in Table 3). Then, we lower the world prices on oil and mineral commodities (second shock identified in Table 3), and we reduce the amount of transfers paid by the rest of the world to the households to implement the third shock identified in Table 3. To model the national shocks, we lower the productivity parameter of the CES function between labour and capital for each activity, to take into account the loss in productivity in labour due to telework and the loss in productivity for capital due to unused capital. To model the increase in transport costs, the margins rate is increased.

We expect the economy to be severely hit as most of the sectors face a decrease in their productivity due to the lockdown. In addition, export-oriented sectors face a decrease in the world demand as South African trading partners also face severe economic downturn. Consequently, these sectors will lay-off workers and the unemployment rate should rise. We thus expect that GDP will fall, unemployment will increase, and due to reduced supply and demand, prices might also fall. Sectoral impacts will depend on the severity of the shock, as well as the linkages to the rest of the economy. In parallel, the decrease in oil price could reduce the production costs for the South African producers as South Africa is a net importer of oil. The reduction in the production of the different activities will impact households as they may be laid-off or see their wage rate decrease. Given the decrease on households' income, we can expect a decrease in households' consumption which will further fuel the decrease in production. Reduced household incomes will lead to increased poverty, especially among the already vulnerable.

4. RESULTS

4.1 Macro Results

The impacts of the simulated COVID-19 pandemic are quite harsh on the economy. Indeed, the economy is simultaneously affected by a supply and a demand shock. On the supply side, the lockdown leads to a decrease in production as capital is largely unused and workers are at home while on the demand side there is a decrease in demand as the rest of the world are reducing their consumption. The combined effect is a reduction by 10.3% in gross domestic product (GDP) in the mild scenario and 14.14% in the severe scenario (Table 4). The reduction in total production leads to a fall of total labour demand from the industries. Consequently, the unemployment rate is sharply increasing for all the different categories of workers. However, for both scenarios, the increase in the unemployment rate is greater for unskilled and semi-skilled workers than for skilled

Table 4. Impacts on macroeconomic variables (in percent except for unemployment (in percentage point))

	Mild	**Severe**
Real GDP	–10.30	–14.14
Consumer index price	–0.64	–0.59
Total investment	–26.75	–35.60
Total labour demand	–5.28	–7.59
Unemployment rate unskilled	8.63	11.35
Unemployment rate semi-skilled	7.26	9.88
Unemployment rate skilled	5.02	7.29
Unemployment rate highly skilled	3.52	5.27

Source: Own computations based on model simulations.

workers. This sharp increase in the unemployment rate is worrying in a country plagued by endemic unemployment. It is likely that households that rely heavily on income from workers with lower education attainment will likely bear the economic brunt of employment income reduction. Of course, as Table 1 shows, households receive income from other sources besides employment, in particular, government social transfers. Therefore, as seen later, it is not obvious that these households will bear the highest brunt of the pandemic.

4.2 Sectoral and Distributional Results

Sectors are affected differently depending on whether they are characterised as essential or not or whether export-oriented or not. Thus, the sectors that are directly negatively affected will reduce their production, not hire labour and reduce their intermediate consumption, thereby impacting other sectors of the economy. Because of the indirect effects, sectors that were initially not identified as being severely affected will find themselves heavily impacted by the resultant decline in the activity of other sectors. As an example, the food sector, which was not identified as a heavily impacted sector ex ante, sees its production declining by 3.77% in the mild scenario and 6.12% in the severe scenario. A large part of this decline is induced by the closure of restaurants and hotels. The effects are even more dramatic for sectors that are export-oriented to the extent that they are no longer able to export their products, given the situation of their trading partners. For example, the mining sector, which is experiencing both a drop in world market prices and a decline in export demand, is seeing its production decrease by 23.16% in the mild scenario and a bit less than 30% in the severe scenario. The construction sector is also hit very harshly given the slowdown of the activities and the drop in investment. Its production declines by 25.71% in the mild scenario and 32.35% in the severe scenario. The retail trade sector suffers relatively less, with a decline of 9.22% in the mild scenario and 13.89% in the severe scenario.

The drop of production in all the sectors leads to a drop in total labour demand, and eventually to an increase in unemployment rates as mentioned above. The impacts on labour demand and unemployment affect households' income. Households' incomes are decreasing for all categories but interestingly, the poorest households experience a lower decrease given that a bigger share of their income comes from government social transfers that the government cushioned from declining during the pandemic. Indeed, as shown in Table 1, the main source of income for the poorest households comes from government's transfers, while richer households rely more on labour income and dividends. Given the

decrease in their income, households reduce their consumption, direct tax payments and savings.

As the situation of all households deteriorates, it is interesting to give a high-level discussion of income distributional shifts from the CGE model first before getting more granular detail using microsimulation analysis in the section below. Looking at the inter-decile gap, which computes the difference between the top and the bottom of the distribution (Decile 9/Decile 1), as well as the De Palma index, which is the ratio of the richest 10% divided by the poorest 40%'s share, each of these indices is decreasing. For the mild scenario, the inter-decile index decreases by 1.3 points while the De Palma index decreases by 0.18 points. This result is important for at least two reasons. First, as was seen for the labour market, it is the least skilled workers who see their situation deteriorate the most (which mainly negatively affects the poorest households). In terms of total household income, it can thus be seen that government transfers lessen the shock for the most vulnerable households. Second, inequality reduces, but not because there is an improvement in the lives of the poorest, but rather because the very rich households' income situation is deteriorating more than that of the poorest.

Firms' income is decreasing given the decrease in capital income, and so are its savings. Government's income is decreasing during the pandemic, respectively, –10.01% and –13.46% in the mild and severe scenarios, given the reduction in the receipts from direct and indirect taxes. Overall, total savings in the economy is decreasing leading to a drop in total investment by –26.75% in the mild scenario and by –35.70% in the severe scenario.

4.3 Micro-Economic Results

CGE models alone cannot fully assess the distributional impacts as they rely on representative households. Therefore, to analyse the distributional impacts of the COVID-19 pandemic simulations on poverty and inequality at the individual household level for the mild and the severe scenarios, a micro-simulation model is used. The percentage changes on households' income and consumer price indices from the macro model are passed onto the micro households data derived from the 2017 NIDS to compute FGT indices and the Gini index to be used for assessing the resulting poverty and inequality impacts, respectively. The poverty line used is the Upper Bound Poverty Line for South Africa of R1227 per person per month in 2019 prices (Statistics South Africa, 2019b).

As Figure 1 shows, the COVID-19 shock and induced lockdown increases the number of poor households by 2.5% points in the mild scenario and 2.6% points in the severe scenario. The depth and severity of poverty increase as well but slightly, which confirms what was found in the macro results.

The Gini-Index decreases in both scenarios by 0.5 and 0.7% points. Therefore, the COVID-19 pandemic increases poverty while inequality decreases. Rich households' income depends more on capital income, dividends and wages, which are severely impacted by COVID-19. Poorest households' income depends strongly on the transfers from the government that were not affected during COVID-19. The COVID-19 pandemic thus moves the income distribution curve such that more poor households fall under the poverty line (*i.e.* increased poverty). At the same time, however, COVID-19 decreases, relatively more, the level of rich households' income and squeezes the income distribution curve (*i.e.* reducing inequality).

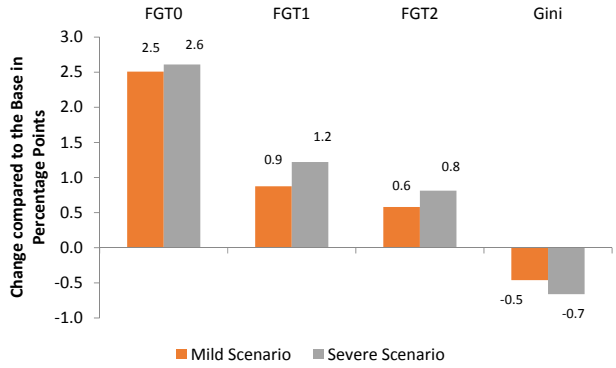

Figure 1. Impacts on poverty and inequality in the scenarios at the micro-economic level.
Notes: *Poverty indices represented by Foster-Greer-Thorbecke (FGT) (FGT0 is headcount, FGT1 is depth, FGT2 is severity) and the Gini-Index by Gini*
Source: Own computations using model simulations and survey data based on NIDS (2017).

5. CONCLUSION

This paper applies a CGE model together with a microsimulation model in top-down fashion to analyse the impact of the COVID-19 pandemic on the South African economy. It is important to note that the pandemic is currently ongoing at the time of writing, and inevitably, as new information becomes available, particularly on the length of the imposed response regulations in both South Africa and the world over, some scenarios might need to be revisited. The approach of the paper was to test two simulations, a mild and a severe one, designed based on judgements informed in part by available literature and in part by government regulations in response to the pandemic. It is important to note that, given the paucity of information on the ongoing pandemic, part of the assumptions to the magnitude of the shock is itself also shrouded by uncertainty, and hence, informed by guestimates. Thus, it is more the directions and intensity of changes, than the actual magnitudes that must be emphasised in this paper. The pathways simulated include, international transmission, local transmission, both demand and supply shocks and transport costs channels. The severe scenario assumes that the length of the lockdown regulations as well as the slowdown in international trade is longer than in the mild scenario.

The impacts are quite severe. The mild case produces a reduction in GDP of –10% while the severe scenario leads to a –14.1% reduction. Unemployment increases sharply due to the pandemic, with lower skilled workers enduring most of the economic downturn and slowdown. This pandemic leads to lower incomes for all households, but because the lower skilled households receive the majority of their income from government transfers that remain largely unchanged through the pandemic, the wealthier households tend to lose disproportionately more. Overall, household poverty increases while inequality falls, though the magnitudes are fairly conservative given the short-term focus of the analysis.

These results, and in particular the distribution results, bear some support to the sentiments expressed recently in the Economist magazine (https://www.economist.com/finance-and-economics/2020/05/16/why-the-pandemic-could-eventually-lower-inequality) that if politicians really want to, they could use this pandemic to at least chart a more egalitarian pathway to going forward. The findings of the paper show the importance of government transfers to the poor in the face of a crisis. Future extensions of this work could refine further the modelling to produce rigorous evidence especially as more information becomes available. The stimulus package announced by the government can also be a fruitful agenda for future modelling work, in which a dynamic model could be used with a combined scenario of the pandemic as well as the stimulus. This also enables explicitly analysing risks posed to fiscal sustainability. Finally, it can be of interest to also model ideal scenarios that show policy makers alternative recovery paths.

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APPENDIX

Table A1. Classification of sectors according to the severity of the COVID-19 shock

Mildly affected	**Moderately affected**	**Severely affected**	**Very severely affected**
	Agriculture, forestry, fishing		
Pharmaceuticals, hygiene and cleaning			
Food and non-alcoholic beverages			Alcoholic beverages and tobacco
		Textiles, clothing, leather and footwear	
		Paper, paper products	Wood, wood products
Petroleum	Basic chemicals, fertiliser, paint, other		
	Plastic, glass		Tyres, rubber products
			Non-metallic minerals and products (cement, concrete, etc.)
			Iron, steel, metal products Machinery and equipment
Electricity, gas, water			
			Machinery and equipment Construction
		Wholesale, retail trade	Accommodation, catering
Communication		Transport and storage	
Finance and insurance, computing services	Real estate, legal and accounting, other support services	Rentals, research, manufacturing services, other business services	
Health services Public administration		Education services	Recreation, other

Source: Adapted from Arndt *et al.* (2020) and Bhorat *et al.* (2020); also informed by government lockdown regulations.